Development of Small-Volume, High-Precision, and Reliable Cryogenic Linear Actuators by Using Novel Intermetallic Compounds

Completed Technology Project (2016 - 2020)

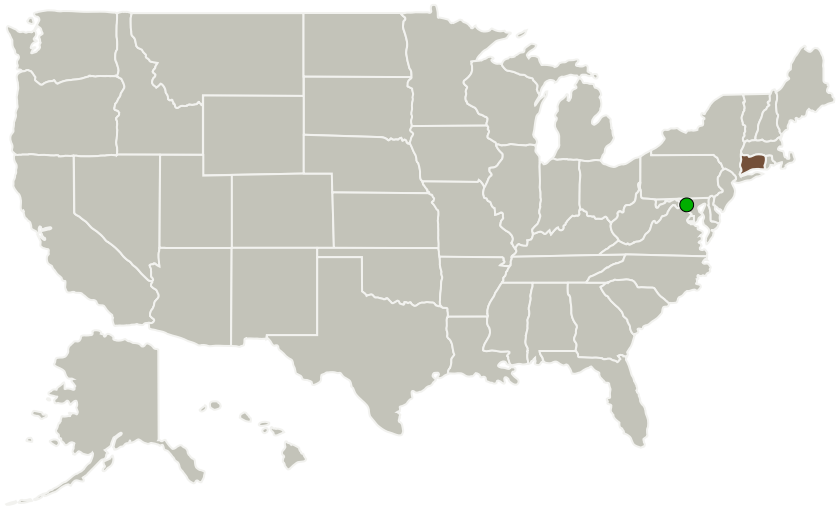
Project Introduction

Space missions often involve ultra-cold environments, and cryogenic actuators must be mechanically robust for long-term cyclic work, generate high power per volume, as well as perform high precision motion in such extreme environments. These demanding requirements have asked a material scientist to seek for a new type of actuator materials. Recently, we discovered a bulk-scale novel intermetallic compound CaFe2As2 that can exhibit superelastic deformation and ultra-high strength, which leads to unusually high actuation power per volume, 10~1000 times larger than most actuator materials, as well as cryogenic linear shape memory effects even near 0 K. The cryogenic linear actuation of this crystal is exceptionally repeatable, precise, and reliable with almost no fatigue damage, which would guarantee the long lifetime and high accuracy in actuation motion. Therefore, the research objective of this proposal is to develop a small-volume, high-precision and mechanically-robust cryogenic linear actuator by performing the combined set of works that include (1) large single crystal growth of novel intermetallic compound CaFe2As2 and related structures, (2) evaluation of their cryogenic linear actuation performance, (3) understanding of fundamental physics behind cryogenic actuation properties, and (4) development of proto-type linear actuators that operates at a temperature between 4 and 150 K.

Anticipated Benefits

This technology will advance the long lifetime and high accuracy in actuation motion.

Primary U.S. Work Locations and Key Partners



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Organizations Performing Work	Role	Type	Location
University of Connecticut	Lead Organization	Academia Asian American Native American Pacific Islander (AANAPISI)	Storrs, Connecticut
Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations
Connecticut

Project Website:

https://www.nasa.gov/strg#.VQb6T0jJzyE

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

University of Connecticut

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

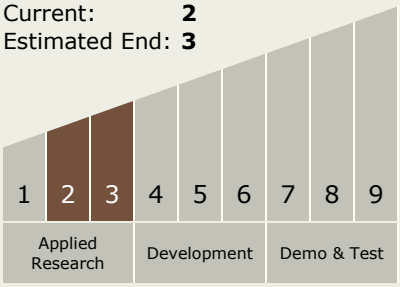
Hung D Nguyen

Principal Investigator:

Seok Woo Lee

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



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Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - TX12.3 Mechanical Systems
    - TX12.3.7 Mechanism Life Extension Systems

Target Destinations

The Moon, Mars, Others Inside the Solar System